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Application No. 10/064,283

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No. : 10/064,283
Applicant : Norman Arnold Turnquist et al.
Filed : 06/28/2002
Title : Brush Seal for a Steam Turbine and Method of Retrofitting
TC/A.U. : 3676
Examiner : PATEL, VISHAL A
Docket No. : 121251
Customer No. : 6147

APPEAL BRIEF UNDER 37 CFR 1.192

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Real party in interest

General Electric Company is the real party in interest.

Related appeals and interferences

None.

Status of claims

On 1 December 2003, Appellants appealed from the final rejection of claims 1-18.
Claims 1-18 were rejected under 35 USC 103(a) over Basu and also over Basu in view of Modell.

Status of amendments

The claims were not amended subsequent to Final Rejection. Appellants had amended paragraph 3 of the Specification. The Advisory Action did not indicate whether this amendment to paragraph 3 would be entered.

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Summary of invention

As described in the Background of Appellants' Specification Paragraphs 3 and 4, it is known in the art of steam turbines to position seals (e.g. brush seals or labyrinth-brush seals) with cobalt-based bristles in a circumferential array between the rotor of the turbine and the circumferentially surrounding casing to minimize steam-path leakage. While the seals with cobalt-based bristles have proved to be quite reliable in steam turbines at temperatures between about 500°F and about 1100°F (also known as high temperatures) and pressures between about 140psia and about 3500psia (also known as high pressures), wear performance of such seals, in conjunction with a NiCrMoV or CrMoV rotor, degrade over time at temperatures between about 100°F and about 500°F (also known as low temperatures) and pressures up to 140psia (also known as low pressures). Accordingly, there is a need in the art for a brush seal having improved wear characteristics at low temperatures and pressures.

As is also described in the Description of Appellants' Specification Paragraph 13, some conventional steam turbines utilize cobalt-based brush seals, for example Haynes 25™ (offered for sale by Haynes International, Kokomo, IN) brush seals. While such cobalt-based brush seals have proved to be reliable in sections of steam turbines having operating temperatures between about 500°F and about 1100°F and pressures between about 140 psia and about 3500 psia, wear performance of such seals typically degrades at temperatures between about 100°F and about 500°F wherein such temperatures typically correspond to sections of the turbine where pressures are generally up to 140 psia. At the low-temperatures and low-pressures described herein, the cobalt-based brush seal typically causes unwanted rotor wear when the steam turbine is in operation. By way of example and not limitation, such rotors typically comprise CrMoV or NiCrMoV rotors.

Appellants have claimed several embodiments to address the need for a brush seal having improved wear characteristics at low temperatures and pressures.

In a first embodiment, represented by Claim 1, FIG. 1 and paragraph 8, a brush seal 100 is disposed in a section of a steam turbine 200 for reducing leakage of a working fluid 110 across a pressure drop. The brush seal 100 comprises a bristle holder 120 attachable to the steam turbine 200 and multiple bristles 130 comprising Ni, Cr, Mo, Fe, W, Mn, V, Si, and C.

In a second embodiment, represented by claim 6, FIG. 1, paragraph 10, a brush seal 100 is disposed in a section of a steam turbine 200 for reducing leakage of a working fluid across a pressure drop. The brush seal 100 comprises a bristle holder 120 attachable to the steam turbine 200 and multiple bristles 130 comprising a low radiation activation material having less than 2.5% Cobalt by weight.

In a third embodiment, represented by claim 16, FIG. 1, paragraph 12, a method of retrofitting a steam turbine 200 comprises providing a stator 140 disposed in the steam turbine 200, providing a rotor

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150 spaced apart from the stator 140 so as to define a gap "G" therebetween and providing a brush seal 100 disposable in a section of the steam turbine 200. The brush seal 100 comprises a plurality of bristles 130 having about 16% Cr, about 16% Mo, about 5% Fe, about 4% W, less than about 2.5% Co, about 1% Mn, about 0.35% V, about 0.08 Si, about 0.01% C and a remainder of Ni.

Issues

Whether claims 1-18 are unpatentable under 35 USC 103(a) over Basu. Whether claims 1-18 are unpatentable under 35 USC 103(a) over Basu in view of Modell.

Grouping of claims

(a) Claim 1, claims 2-5 which depend therefrom, claim 11, and claims 12-15 which depend therefrom, stand or fall together.

(b) Claims 6 and claims 7-10 which depend therefrom stand or fall together.

(c) Claim 16 and claims 17-18 which depend therefrom stand or fall together.

Argument

Explanation of why Claims 1-5 and 11-15; Claims 6-10; and Claims 16-18 are separately patentable from each other

Claims 1-5 and 11-15 recite "said plurality of bristles comprising Ni, Cr, Mo, Fe, W, Mn, V, Si, and C" and "said plurality of bristles consists essentially of Ni, Cr, Mo, Fe, W, Co, Mn, V, Si, and C." Claims 6-10 do not include such recitations but instead recite "said plurality of bristles comprising a low radiation activation material, said material having less than 2.5% Cobalt by weight."

Although a goal of the embodiments of claims 1-5 and 11-15 is to minimize Cobalt, it is possible that other material combinations exist which result in a material having less than 2.5% Cobalt by weight. The embodiments of claim 1-5 and 11-15 represent one combination which has been found to be particularly useful as described in the Experiment section of Appellant's Specification.

With respect to claim 16, this claim includes a combination of some of the recitations of claims 1 and 6: "a plurality of bristles having about 16% Cr, about 16% Mo, about 5% Fe, about 4% W, less than about 2.5% Co, about 1% Mn, about 0.35% V, about 0.08 Si, about 0.01% C and a remainder of Ni." The combination of such features is believed to make it separately patentable from either claim 1 or claim 6.

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Brief Characterization of the Prior Art Relied on in the Final Rejection*Basu, US Patent No. 5,884,918*

Basu addresses the issue of "recessed back plate" in brush seals, which causes uneven wear of the seal. Basu describes a brush seal with a bristle holder and bristles, but the bristles of Basu do not address the problem of wear performance at low temperatures and pressures, and as addressed by the Appellants.

Modell, US Patent No. 5,252,224

Modell teaches a reactor tube cleaning brush, the brush comprising bristles made of Hastelloy. Modell is concerned with "removing solids collected in tubular reactor 12", and "whereby solids which collect along tubular reactor 12 are removed periodically by directing brush 122 through the length of the tubular reactor 12" (line 8 - 14, Column 12) by these bristles. In summary, the goal of the bristles taught by Modell is to remove the scales / solids from the reactor walls, unlike the bristles described by the Appellants, which are effective in inhibiting pressure loss.

Discussion of the issues presented by the final rejection*Whether claims 1-18 are unpatentable under 35 USC 103(a) over Basu*

With respect to the 35 USC 103(a) rejection based on Basu (alone), the Examiner's primary statements appear to be that (1) use of a known materials on basis of its suitability for intended use as a matter of obvious design choice; and (2) "Furthermore evidence is shown of art equivalent material by Modell, that form bristles from materials such as nickel alloy or Hastelloy."

With respect to the design choice statement, Appellants refer to MPEP 2144.07 (Art Recognized Suitability for an Intended Purpose):

The selection of a known material based on its suitability for its intended use supported a *prima facie* obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945) (Claims to a printing ink comprising a solvent having the vapor pressure characteristics of butyl carbitol so that the ink would not dry at room temperature but would dry quickly upon heating were held invalid over a reference teaching a printing ink made with a different solvent that was nonvolatile at room temperature but highly volatile when heated in view of an article which taught the desired boiling point and vapor pressure characteristics of a solvent for printing inks and a catalog teaching the boiling point and vapor pressure characteristics of butyl carbitol. "Reading a list and selecting a known compound to meet known requirements is

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no more ingenious than selecting the last piece to put in the last opening in a jig-saw puzzle." 325 U.S. at 335, 65 USPQ at 301.).

See also *In re Leshin*, 227 F.2d 197, 125 USPQ 416 (CCPA 1960) (selection of a known plastic to make a container of a type made of plastics prior to the invention was held to be obvious); *Ryco, Inc. v. Ag-Bag Corp.*, 857 F.2d 1418, 8 USPQ2d 1323 (Fed. Cir. 1988) (Claimed agricultural bagging machine, which differed from a prior art machine only in that the brake means were hydraulically operated rather than mechanically operated, was held to be obvious over the prior art machine in view of references which disclosed hydraulic brakes for performing the same function, albeit in a different environment.).

In these cases, for example *Ryco*, performing the same function appears to be significant. In Appellants' invention, a need was discovered for a brush seal (with a "sealing" function) having improved wear characteristics at low temperatures and pressures. Appellants then used diligence to identify a solution, which is articulated in the claims.

The success of Appellants solution is described in Appellants' Specification Paragraphs 14-17:

[0014] Applicants conducted experiments in a test rig to simulate conditions of the brush seal of the present invention disposed in a steam turbine 200. An aspect is discussed in the following example.

[0015] A brush seal comprising about 15% Cr, 16% Mo, 5% Fe, 3.1% W, 1.7% Co, 0.46% Mn, 0.15% V, about 0.08 Si, about 0.01% C and 56% Ni was disposed adjacent a rotor to allow testing of the brush seal at various bristle to rotor clearances (also known as assembly clearance). The brush seal that was used had a bristle pack density of about 1900 bristles per inch and a bristle diameter of about 0.0056 inches. In addition, a cant angle between the rotor and bristles was about 45 degrees. The test comprised spinning the rotor at a surface speed of about 400 feet per second in compressed gas.

[0016] The results indicated that for assembly clearances up to 0.025 inches the resistance to leakage between the seal and the rotor was three to ten times of an improvement compared to traditional labyrinth-type seals that are typically used in low-pressure steam turbine applications. The measured brush seal leakage rate in the abovementioned test indicated that the gap "G" was in the range between about 0.004 inches and about 0.005 inches compared to the traditional labyrinth-type seals that typically have a gap "G" in the range between about 0.015 inches and about 0.025 inches.

[0017] Furthermore, accelerated wear tests were conducted in which the brush seal of the present invention was allowed to interfere with a spinning NiCrMoV rotor at a temperature about 325°F in saturated steam for a time of about 40 hours. The results of the accelerated wear tests indicated that the measured bristle-to-rotor wear was negligible (e.g. no measurable wear characteristics) compared to cobalt-based brush seals at similar conditions (e.g. cobalt-based brush seal having measurable wear in the range between about 0.003 inches and about 0.005 inches). As such, the accelerated wear tests indicated improved sealing capability between the rotor and brush seal of the present invention compared to conventional cobalt-based brush seals.

The specific example fits more particularly within the ranges of the sets of Claims 1-5 and 11-15 and Claims 16-18. However, as described above, it is submitted that the claim 6 recitation of "material having less than 2.5% Cobalt by weight" is beneficial to achieving these results as well.

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With respect to the statement "evidence is shown of art equivalent by Modell," Appellants do not entirely understand how the Examiner is characterizing Modell as "art equivalent," particularly in light of the fact that Modell relates to cleaning bristles and not to sealing bristles. More specifically, if the Examiner intended the words to mean that there is an equivalence between Hastelloy and all other nickel alloys, Appellants respectfully traverse such statement and submit that these alloys are not equivalent.

In sealing applications, the state of the art for 20 years has been related to materials which were adequate for the conditions at the time. Cobalt based alloys are particularly suitable for high temperature and high pressure applications. It was not recognized that a different set of alloys would be needed for low temperature and low pressure applications. Upon recognizing this, to select materials for this different set of conditions, Appellants worked toward the invention of the present Application and were successful as can be seen by the above quoted Specification Paragraphs 14-17.

Whether claims 1-18 are unpatentable under 35 USC 103(a) over Basu in view of Modell

With respect to the 35 USC 103(a) rejection based on Basu in view of Modell, the Examiner's primary statements appear to be that "[H]aving one nickel or another nickel alloy for bristle is considered to be art equivalent and providing bristle that have better integrity."

With respect to the art equivalent statement, Appellants refer to MPEP 2144.06 (Art Recognized Equivalence for the Same Purpose - COMBINING EQUIVALENTS KNOWN FOR THE SAME PURPOSE):

"It is *prima facie* obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition to be used for the very same purpose.... [T]he idea of combining them flows logically from their having been individually taught in the prior art." *In re Kerkhoven*, 626 F.2d 846, 850, 205 USPQ 1069, 1072 (CCPA 1980) (citations omitted) (Claims to a process of preparing a spray-dried detergent by mixing together two conventional spray-dried detergents were held to be *prima facie* obvious.). See also *In re Crockett*, 279 F.2d 274, 126 USPQ 186 (CCPA 1960) (Claims directed to a method and material for treating cast iron using a mixture comprising calcium carbide and magnesium oxide were held unpatentable over prior art disclosures that the aforementioned components individually promote the formation of a nodular structure in cast iron.); and *Ex parte Quadranti*, 25 USPQ2d 1071 (Bd. Pat. App. & Inter. 1992) (mixture of two known herbicides held *prima facie* obvious). But see *In re Geiger*, 815 F.2d 686, 2 USPQ2d 1276 (Fed. Cir. 1987) ("Based upon the prior art and the fact that each of the three components of the composition used in the claimed method is conventionally employed in the art for treating cooling water systems, the board held that it would have been *prima facie* obvious, within the meaning of 35 U.S.C. 103, to employ these components in combination for their known functions and to optimize the amount of each additive.... Appellant argues... hindsight reconstruction or at best... 'obvious to try'.... We agree with appellant.").

Appellants note that the use of art equivalents for the question of obviousness seems to be importantly hinged on whether the equivalents have the same purpose. In the present case, where the purpose is the utility of the bristles, it is not enough to state that "one nickel or another nickel alloy for bristle is considered

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to be art equivalent," because the purpose lies not in making the bristle, but in the making the bristle having a specific utility. Appellants respectfully submit that cleaning bristles, for which Modell utilizes "one nickel or another nickel alloy" (Col 14, line 47) are not pertinent to the field of Appellant's endeavor, which is providing sealing using high density packed bristles. More specifically, Appellants do not understand how a person of ordinary skill, seeking to solve a problem of finding appropriate bristle material for brush seals, utilized for sealing purposes in turbines, would reasonably be expected or motivated to look to cleaning bristles.

The arguments over art equivalents notwithstanding, Appellants further note that "[I]t is immaterial to the issue of obviousness that elements of the claimed invention exist in other contexts." *The Gillette Co. v. S.C. Johnson & Son Inc.*, 16 U.S.P.Q.2d 1923, 1927 (Fed. Cir. 1990). Appellants submit that there exists no reasonable expectation of success when using a cleaning bristle in a sealing context. If there is no reasonable expectation of success, there exists no motivation to combine the two references.

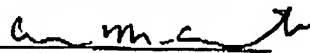
Accordingly, Appellants respectfully traverse the rejection of claims 1, 6, 11 and 18, and submit that the Final Office Action has not set forth a prima facie case of obviousness with respect to claims 1, 6, 11 and 18. Claims 2-5, 7-10, 12-15 and 17-18 depend respectively from claims 1, 6, 11 and 18.

Therefore, Appellants respectfully submit that the claimed invention defines allowable subject matter over the applied art. Withdrawal of the rejections is respectfully requested, and allowance of the claims is respectfully solicited.

Summary

In view of the foregoing, Appellant respectfully submits that the application is in condition for allowance. Favorable reconsideration and prompt allowance of the application are respectfully requested.

Respectfully submitted,


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Appendix

1. A brush seal, disposed in a section of a steam turbine, for reducing leakage of a working fluid across a pressure drop, said brush seal comprising:

a bristle holder attachable to said steam turbine; and

a plurality of bristles coupled to said bristle holder, said plurality of bristles comprising Ni, Cr, Mo, Fe, W, Mn, V, Si, and C.
2. The brush seal of claim 1, wherein an energy source of said steam turbine is selected from the group consisting essentially of nuclear plants, fossil-fuel plants and combined cycle plants.
3. The brush seal of claim 1, wherein each of said plurality of bristles comprises about 16% Cr, about 16% Mo, about 5% Fe, about 4% W, less than about 2.5% Co, about 1% Mn, about 0.35% V, about 0.08 Si, about 0.01% C and a remainder of Ni.
4. The brush seal of claim 1, wherein the operating temperature of said section is in the range between about 100°F and about 500°F.
5. The brush seal of claim 1, wherein the operating pressure of said section is up to about 160psia.
6. A brush seal, disposed in a section of a steam turbine, for reducing leakage of a working fluid across a pressure drop, said brush seal comprising:

a bristle holder attachable to said steam turbine; and

a plurality of bristles coupled to said bristle holder, said plurality of bristles comprising a low radiation activation material, said material having less than 2.5% Cobalt by weight.
7. The brush seal of claim 6, wherein an energy source of said steam turbine is selected from the group consisting essentially of nuclear plants, fossil-fuel plants and combined cycle plants.
8. The brush seal of claim 6, wherein each of said plurality of bristles comprises about 16% Cr, about 16% Mo, about 5% Fe, about 4% W, about 1% Mn, about 0.35% V, about 0.08 Si, about 0.01% C and a remainder of Ni.
9. The brush seal of claim 6, wherein the operating temperature of said section is in the range between about 100°F and about 500°F.

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10. The brush seal of claim 6, wherein the operating pressure of said section is up to about 160 psia.
11. A steam turbine comprising:
- a stator disposed in said steam turbine;
 - a rotor spaced apart from said stator so as to define a gap therebetween; and
 - a brush seal disposed in a section of said steam turbine, said brush seal comprising:
 - a) a bristle holder coupled to said stator; and
 - b) a plurality of bristles coupled to said bristle holder and wherein said plurality of bristles consists essentially of Ni, Cr, Mo, Fe, W, Co, Mn, V, Si, and C.
12. The steam turbine of claim 11, wherein an energy source of said steam turbine is selected from the group consisting essentially of nuclear plants, fossil-fuel plants and combined cycle plants.
13. The steam turbine of claim 11, wherein each of said plurality of bristles comprises about 16% Cr, about 16% Mo, about 5% Fe, about 4% W, less than about 2.5% Co, about 1% Mn, about 0.35% V, about 0.08 Si, about 0.01% C and a remainder of Ni.
14. The steam turbine of claim 11, wherein the operating temperature of said section is in the range between about 100°F and about 500°F.
15. The steam turbine of claim 11, wherein the operating pressure of said section is up to about 160 psia.
16. A method of retrofitting a steam turbine comprising:
- providing a stator; said stator disposed in said steam turbine;
 - providing a rotor, said rotor spaced apart from said stator so as to define a gap therebetween; and
 - providing a brush seal, said brush seal being disposable in a section of said steam turbine,

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wherein said brush seal comprises a plurality of bristles having about 16% Cr, about 16% Mo, about 5% Fe, about 4% W, less than about 2.5% Co, about 1% Mn, about 0.35% V, about 0.08 Si, about 0.01% C and a remainder of Ni.

17. The method of claim 16, further comprising operating said section of said steam turbine at a temperature in the range between about 100°F and about 500°F.

18. The method of claim 16, further comprising operating said section of said steam turbine at a pressure up to about 160 psia.

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Serial No.: 10/064,283

Filed: June 28, 2002

For: BRUSH SEAL FOR A STEAM TURBINE AND METHOD OF RETROFITTING

GE Co. Docket No.: 121251

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